

SUPPORT FOR THE AMENDMENT

This Amendment adds new Claim 23. Support for the amendments is found in the specification and claims as originally filed. In particular, support for new Claim 23 is found in the specification at least at page 8, lines 9-16. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 4-13 and 21-23 will be pending in this application. Claim 4 is independent.

REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

Applicants thank the Examiner for the indication that Claim 7 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Office Action at page 11, lines 15-17. However, for the reasons discussed below, Applicants respectfully submit that all of the pending claims are allowable.

Applicants thank the Examiner for the courtesies extended to their representative during the personal interview on December 21, 2005. Applicants thank the Examiner for the indication during the interview that "[a]greement with respect to the claims ... was reached" that "Khan et al. fails to disclose a first single crystalline buffer layer of AlN". Interview Summary dated December 21, 2005.

The present invention provides a nitride compound semiconductor element that can be produced with high yield because a first single crystalline buffer layer of AlN and a second single crystalline layer of  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  are sandwiched between a sapphire substrate and a device structure in the nitride compound semiconductor element. The single crystalline layers of AlN and  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  reduce substrate warpage that occurs when a conventional AlN

buffer layer that is amorphous or polycrystalline is used. See specification at page 1, line 28 to page 2, line 4; page 5, line 35 to page 6, line 2; and FIGS. 1(a) to 1(c), reproduced below.

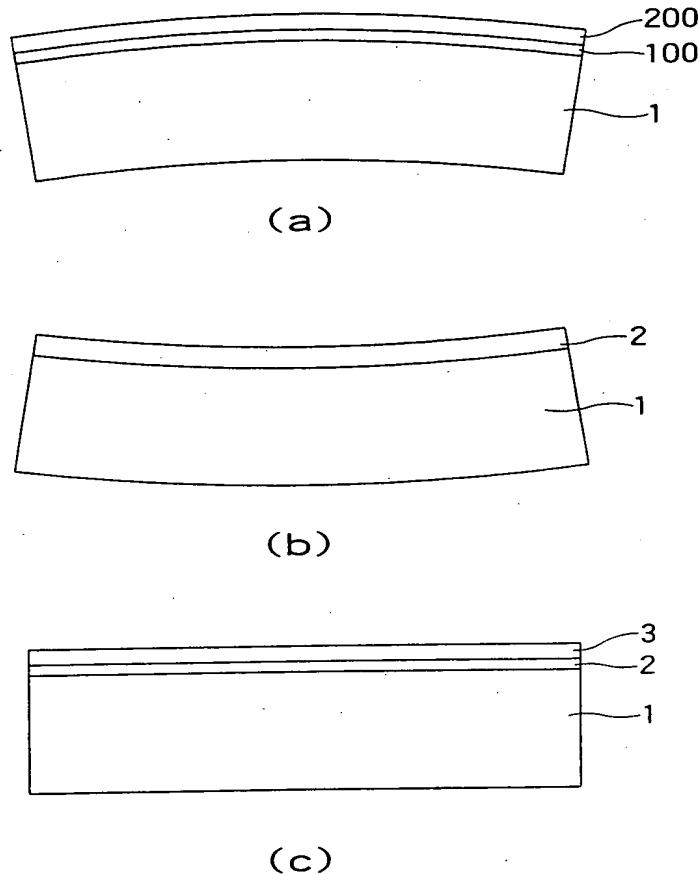


FIG. 1

FIG. 1(a) shows that when a nitride compound semiconductor layer 200 is deposited on a conventional AlN buffer layer 100 on a sapphire substrate 1, the sapphire substrate 1 becomes warped so as to be convex toward the nitride semiconductor layer 200. Specification at page 5, lines 27-35.

However, as shown in FIG. 1(b), the present inventor has discovered that, contrary to prior-art commonsense, a single crystalline AlN buffer layer 2 deposited on sapphire substrate 1 causes the sapphire substrate 1 to become warped so as to be concave. Specification at page 6, lines 3-7.

The present inventor has also discovered, as shown in FIG. 1(c), that when a single crystalline AlGaN layer 3 having a lattice constant slightly larger than AlN, an Al mole fraction in a range of 0.8 to 0.97, and a thickness in a range of 0.3 to 6  $\mu\text{m}$  is formed on the single crystalline AlN buffer layer 2, the warping of the sapphire substrate 1 and stress in the single crystalline AlGaN layer 3 diminish. Specification at page 6, lines 20-26. The reduction in warpage of the sapphire substrate 1 allows crystal growth on larger substrates and improves productivity and/or yield. Specification at page 7, lines 17-18.

Claims 4 (sic), 5 and 21-22 are rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 5,146,465 ("Khan") in view of U.S. Patent No. 6,218,293 ("Kraus") and U.S. Patent No. 6,661,822 ("Kubota"). In addition, Claims 6 and 10 are rejected under 35 U.S.C. § 103(a) over Khan and Kraus and further in view of Kubota. Claim 8 is rejected under 35 U.S.C. § 103(a) over Khan, Kraus and Kubota and further in view of U.S. Patent Application Publication No. US 2001/0038656 A1 ("Takeuchi"). Claim 9 is rejected under 35 U.S.C. § 103(a) over Khan, Kraus, Kubota and Takeuchi and further in view of U.S. Patent Application Publication No. US 2001/0048114 A1 ("Morita"). Claims 11-12 are rejected under 35 U.S.C. § 103(a) over Khan, Kraus and Kubota and further in view of U.S. Patent No. 5,915,164 ("Taskar"). Claims 13 is rejected under 35 U.S.C. § 103(a) over Khan, Kraus, Kubota and Taskar and further in view of U.S. Patent Application Publication No. US 2002/001864 A1 ("Ishikawa").

Khan relates to surface emitting and edge emitting lasers based on aluminum gallium nitride / gallium nitride heterostructures. Khan at column 1, lines 5-9. Khan discloses an

apparatus and method for creating single crystal gallium nitride (GaN) layers over basal plane sapphire substrates. Khan at column 2, lines 55-57. Khan discloses a thin buffer layer of aluminum nitride (AlN) deposited prior to the growth of the gallium nitride layer. Khan at column 3, lines 45-48; column 8 lines 11-14. Khan discloses that the buffer layer of aluminum nitride "facilitates deposition of subsequent layers which may have difficulty bonding directly to substrate 6" of sapphire. Khan at column 6, lines 6-11.

However, Khan is silent about the morphology of the AlN buffer layer and fails to suggest the independent Claim 4 limitation of "a first *single crystalline* layer of AlN formed on said sapphire substrate".

Kraus and Kubota fail to remedy the deficiencies of Khan. The Office Action asserts at page 3, lines 13-15, that "Kraus et al. teach an AlN layer doped with carbon having a concentration of equal to or more than  $3 \times 10^{18} \text{ cm}^{-3}$  (sic) and equal to or less than  $1 \times 10^{20} \text{ cm}^{-3}$ ". The Office Action asserts at page 3, lines 16-18, that "Kubota et al. teach an  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  layer 47 having a thickness of more than  $0 \mu\text{m}$  and less than (sic)  $5 \mu\text{m}$  [citation omitted] which is in the range of equal to or more than  $0.7 \mu\text{m}$  and equal to or less than  $3 \mu\text{m}$ ". However, Kraus and Kubota fail to remedy the deficiencies of Khan with respect to independent Claim 4.

Because the cited prior art fails to suggest the independent Claim 4 limitation of "a first *single crystalline* layer of AlN formed on said sapphire substrate", the prior art rejections should be withdrawn.

Applicants respectfully request, for the reasons provided in the Amendment filed August 30, 2005, that the Examiner acknowledge consideration of the AO and AW references cited in parent 10/188,744 and cited in the IDS filed February 9, 2004, in the above-identified application. For the Examiner's convenience a copy of the Form PTO-1449 from the IDS filed February 9, 2004, is attached.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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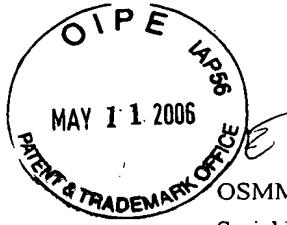
Attached:

Form PTO-1449 from IDS filed February 9, 2004, and date-stamped filing receipt

Customer Number

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(OSMMN 08/03)



OSMM&N File No. 248760US0RD

Serial No. \_\_\_\_\_

In the matter of the Application of: Yasuo OHBA

For: NITRIDE COMPOUND SEMICONDUCTOR ELEMENT

Dept.: CHEMICAL  
By: NFO/CPU/wmb

**Due Date: FEBRUARY 8, 2004**

The following has been received in the U.S. Patent Office on the date stamped hereon:

- 30 pp. Specification 20 Claims/Drawings 8 Sheets and  
2 Pages Application Data Sheet
- Combined Declaration, Petition & Power of Attorney 3 Pages
- Utility Patent Application Transmittal
- Request for Priority
- Check for \$770.00  Dep. Acct. Order Form
- Fee Transmittal Form
- Information Disclosure Statement  PTO-1449 (3)
- White Advance Serial Number Card
- Preliminary Amendment (7 pp.)

